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Manning et al.

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(54) **METHOD FOR UPDATING AN R-P CONNECTION FOR A ROAMING MOBILE STATION**

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(51) **Int. Cl.**[7] **H04Q 7/20**

(52) **U.S. Cl.** **370/331**; 455/432; 455/433; 455/435; 455/436; 455/439; 370/338; 370/349

(58) **Field of Search** 455/432, 433, 455/435, 436, 439, 440, 522, 426, 414; 370/331, 338, 349

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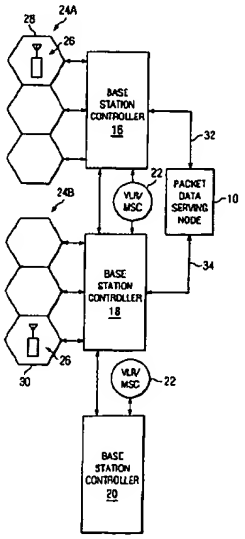
(57) **ABSTRACT**

A system and method for timely maintaining or establishing an R-P connection after a mobile station (MS) roams from the control of an old base station controller (BSC) to that of a new BSC is provided. The process may be initiated during a registration process of the MS, during an origination process, or during a termination process. A Mobile Service Center (MSC), Visitor's Location Register (VLR), or the MS may be used to store the packet data call status information including point to point protocol (PPP) session status information and configuration information about an old BSC including its related cells and PDSNs. In some cases, this information may also be transferred to the new BSC through a BSC to BSC connection.

48 Claims, 9 Drawing Sheets



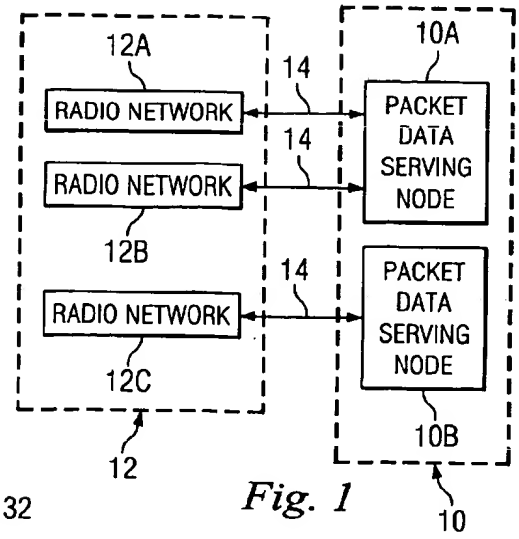

12A
RADIO NETWORK
RADIO NETWORK
RADIO NETWORK
12B
12C
12
14
14
14
10A
PACKET DATA SERVING NODE
PACKET DATA SERVING NODE
10B
10

Fig. 1

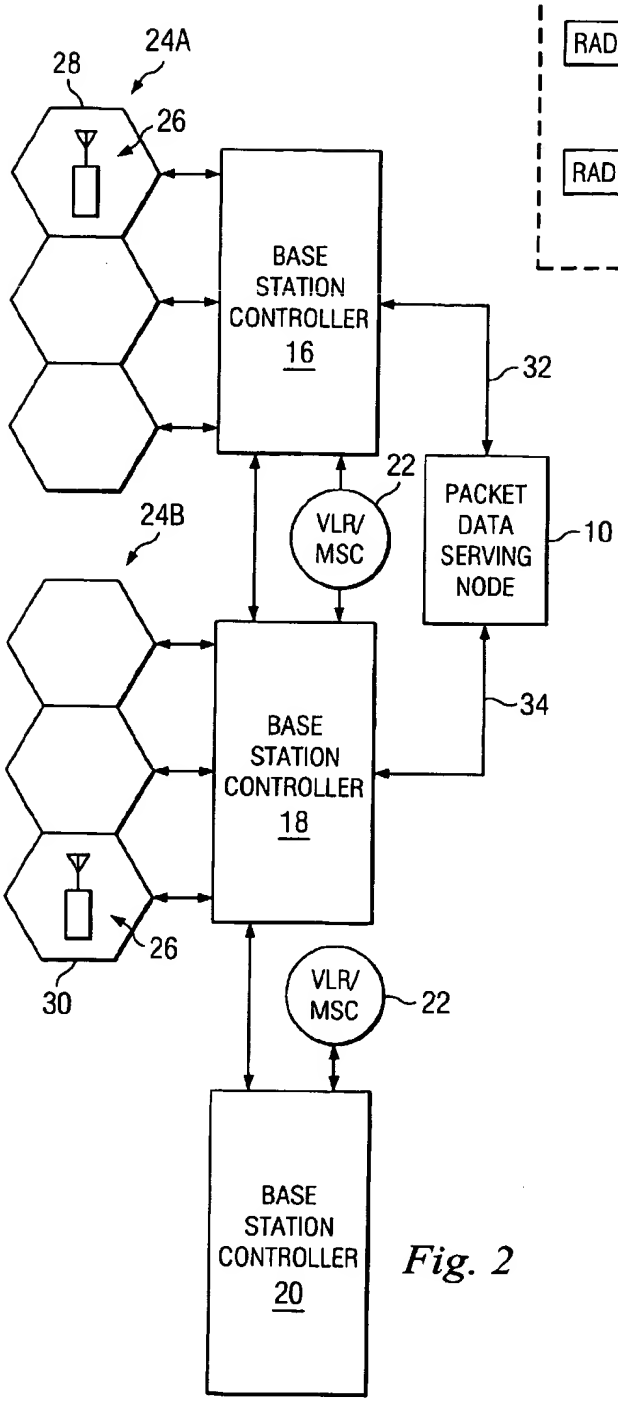

24A
28
26
BASE STATION CONTROLLER 16
32
22
VLR/ MSC
PACKET DATA SERVING NODE
10
24B
BASE STATION CONTROLLER 18
34
26
30
VLR/ MSC
22
BASE STATION CONTROLLER 20

Fig. 2

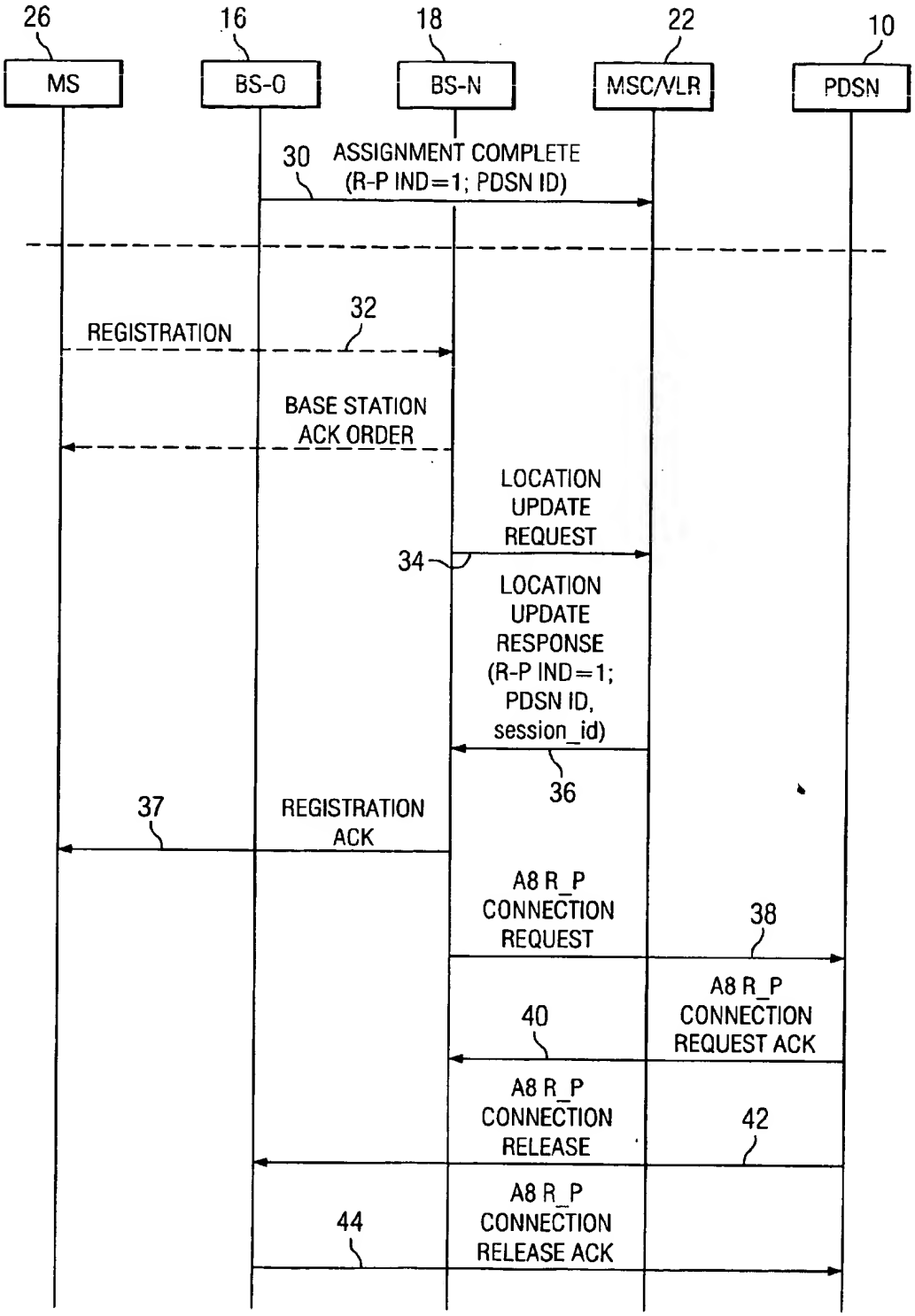

26
16
18
22
10
MS
BS-0
BS-N
MSC/VLR
PDSN
30
ASSIGNMENT COMPLETE
(R-P IND=1; PDSN ID)
32
REGISTRATION
BASE STATION
ACK ORDER
LOCATION
UPDATE
REQUEST
34
LOCATION
UPDATE
RESPONSE
(R-P IND=1;
PDSN ID,
session_id)
36
37
REGISTRATION
ACK
A8 R_P
CONNECTION
REQUEST
38
40
A8 R_P
CONNECTION
REQUEST ACK
A8 R_P
CONNECTION
RELEASE
42
44
A8 R_P
CONNECTION
RELEASE ACK

Fig. 3

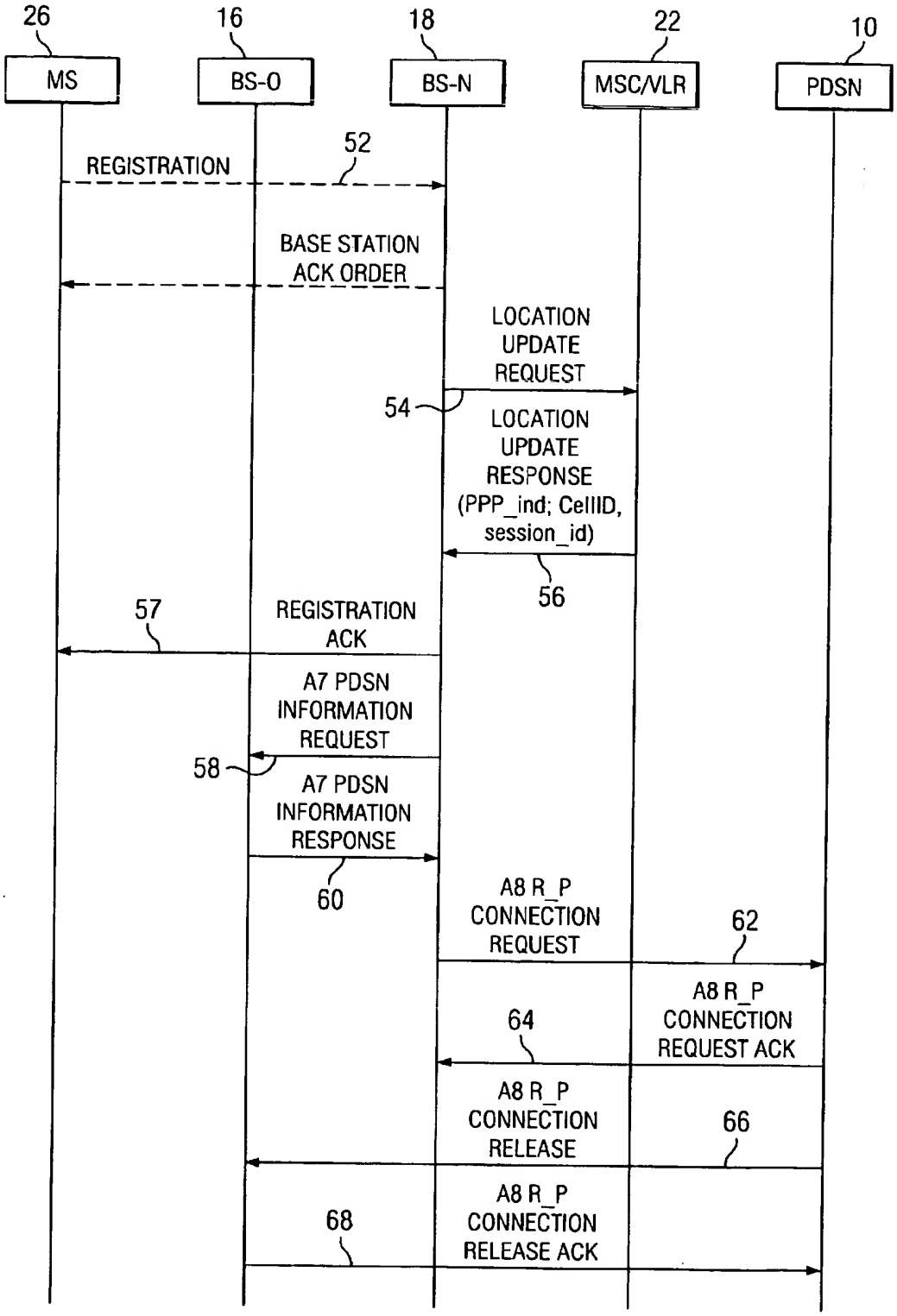

26
16
18
22
10
MS
BS-0
BS-N
MSC/VLR
PDSN
52
REGISTRATION
BASE STATION ACK ORDER
LOCATION UPDATE REQUEST
54
LOCATION UPDATE RESPONSE (PPP_ind; CellID, session_id)
56
57
REGISTRATION ACK
A7 PDSN INFORMATION REQUEST
58
A7 PDSN INFORMATION RESPONSE
60
A8 R_P CONNECTION REQUEST
62
A8 R_P CONNECTION REQUEST ACK
64
A8 R_P CONNECTION RELEASE
66
A8 R_P CONNECTION RELEASE ACK
68

Fig. 4

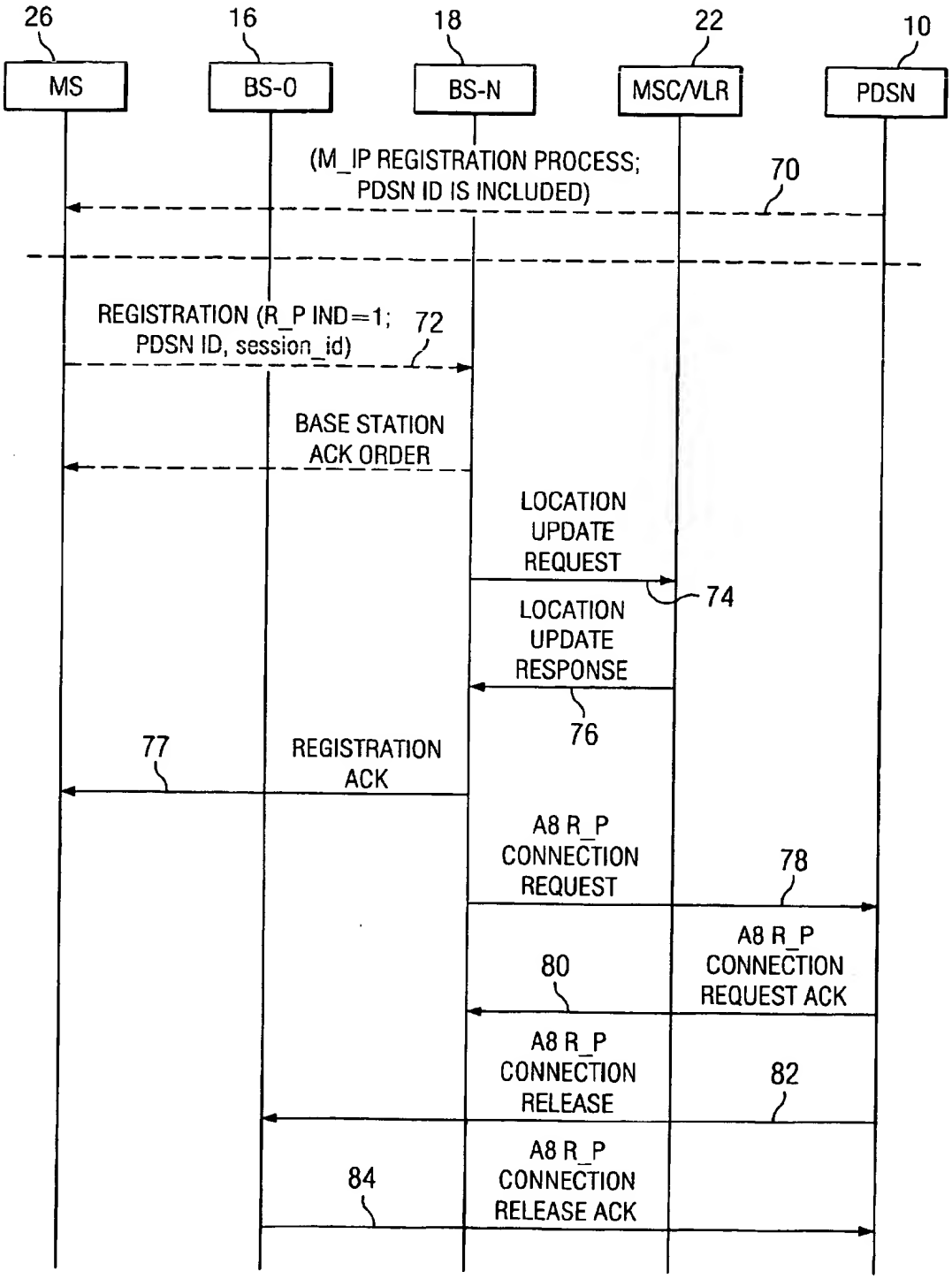

26
16
18
22
10
MS
BS-0
BS-N
MSC/VLR
PDSN
(M_IP REGISTRATION PROCESS;
PDSN ID IS INCLUDED)
70
REGISTRATION (R_P IND=1;
PDSN ID, session_id)
72
BASE STATION
ACK ORDER
LOCATION
UPDATE
REQUEST
74
LOCATION
UPDATE
RESPONSE
76
77
REGISTRATION
ACK
A8 R_P
CONNECTION
REQUEST
78
80
A8 R_P
CONNECTION
REQUEST ACK
A8 R_P
CONNECTION
RELEASE
82
84
A8 R_P
CONNECTION
RELEASE ACK

Fig. 5

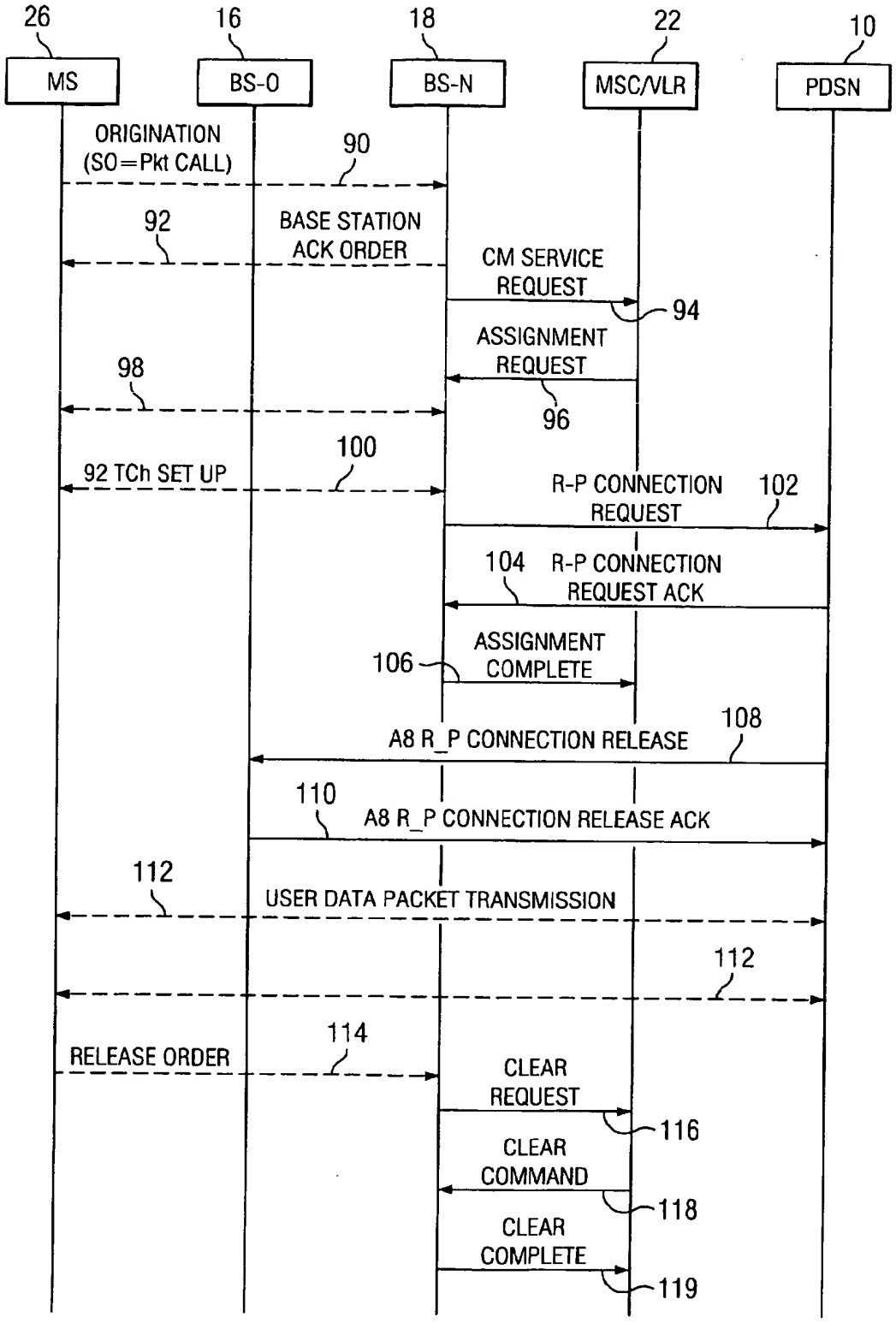

26
16
18
22
10
MS
BS-0
BS-N
MSC/VLR
PDSN
ORIGINATION (SO=Pkt CALL)
90
92
BASE STATION ACK ORDER
CM SERVICE REQUEST
94
ASSIGNMENT REQUEST
98
96
100
92 TCh SET UP
R-P CONNECTION REQUEST
102
104
R-P CONNECTION REQUEST ACK
ASSIGNMENT COMPLETE
106
108
A8 R_P CONNECTION RELEASE
110
A8 R_P CONNECTION RELEASE ACK
112
USER DATA PACKET TRANSMISSION
112
114
RELEASE ORDER
CLEAR REQUEST
116
CLEAR COMMAND
118
CLEAR COMPLETE
119

Fig. 6

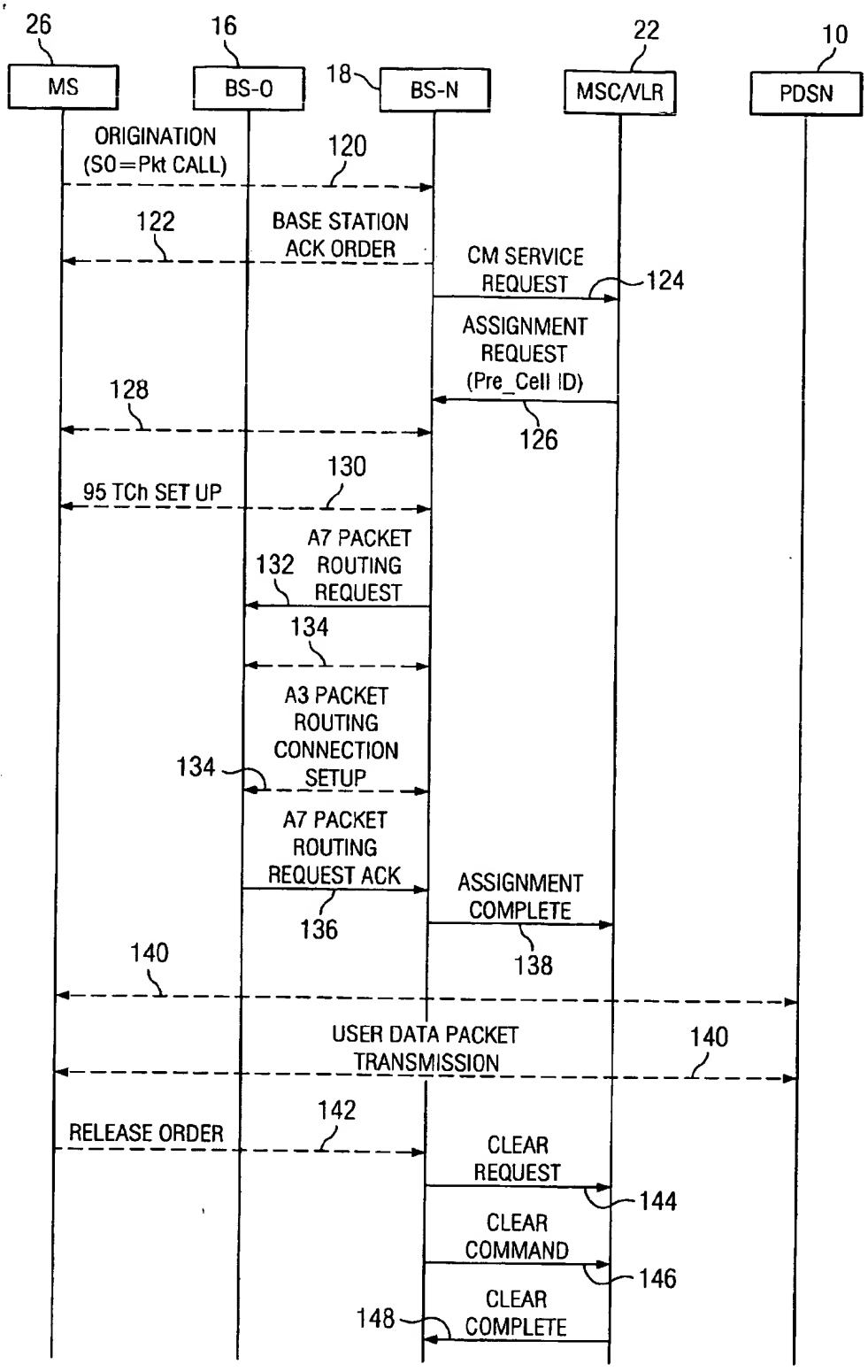

26
MS
16
BS-0
18
BS-N
22
MSC/VLR
10
PDSN
ORIGINATION (SO=Pkt CALL)
120
122
BASE STATION ACK ORDER
CM SERVICE REQUEST
124
ASSIGNMENT REQUEST (Pre_Cell ID)
126
128
130
95 TCh SET UP
A7 PACKET ROUTING REQUEST
132
134
A3 PACKET ROUTING CONNECTION SETUP
134
A7 PACKET ROUTING REQUEST ACK
136
ASSIGNMENT COMPLETE
138
140
USER DATA PACKET TRANSMISSION
140
142
RELEASE ORDER
CLEAR REQUEST
144
CLEAR COMMAND
146
148
CLEAR COMPLETE

Fig. 7

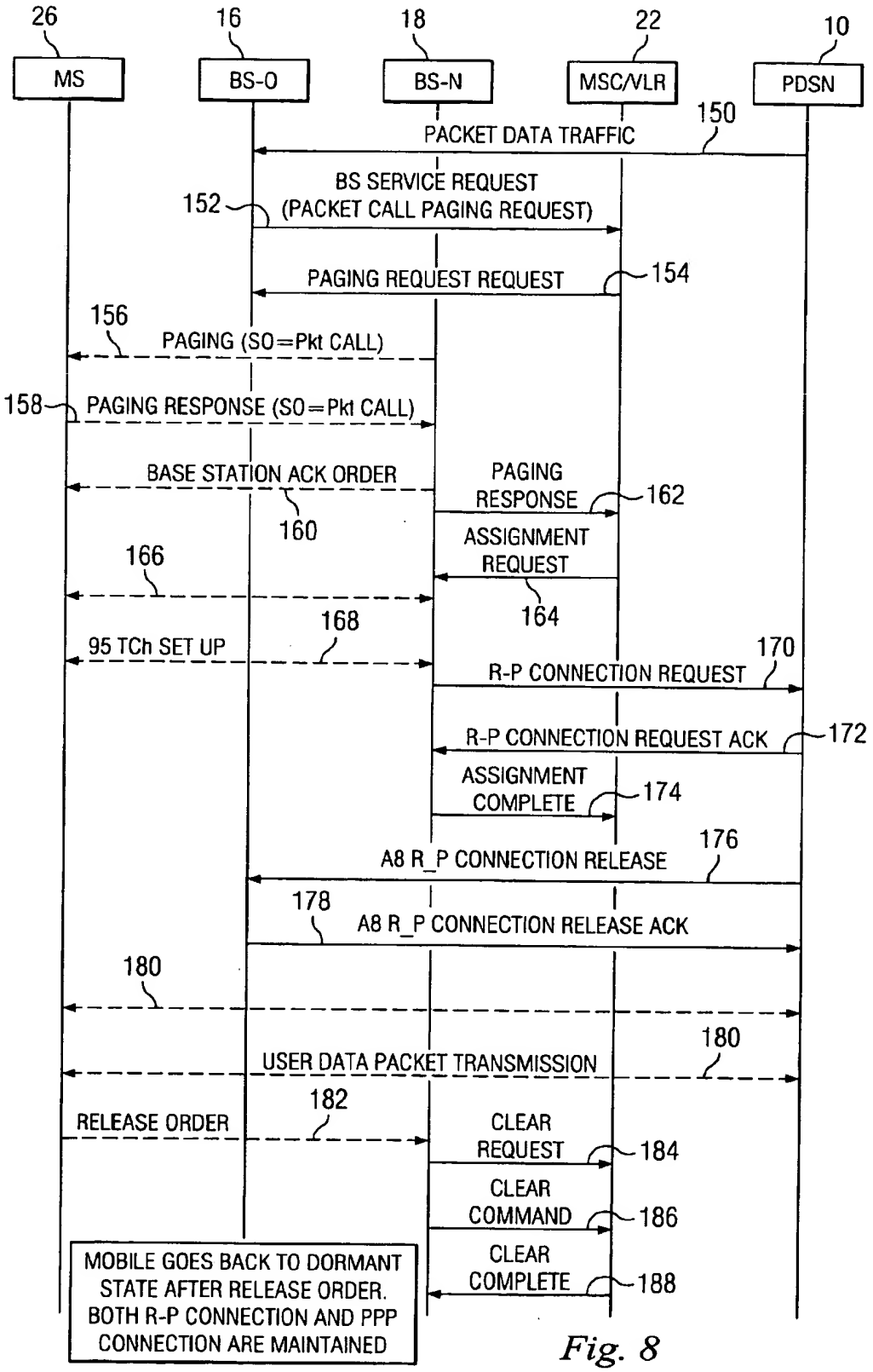

26
MS
16
BS-0
18
BS-N
22
MSC/VLR
10
PDSN
150
PACKET DATA TRAFFIC
152
BS SERVICE REQUEST
(PACKET CALL PAGING REQUEST)
PAGING REQUEST REQUEST
154
156
PAGING (SO=Pkt CALL)
158
PAGING RESPONSE (SO=Pkt CALL)
BASE STATION ACK ORDER
160
PAGING
RESPONSE
162
ASSIGNMENT
REQUEST
164
166
168
95 TCh SET UP
170
R-P CONNECTION REQUEST
R-P CONNECTION REQUEST ACK
172
ASSIGNMENT
COMPLETE
174
176
A8 R_P CONNECTION RELEASE
178
A8 R_P CONNECTION RELEASE ACK
180
180
USER DATA PACKET TRANSMISSION
182
RELEASE ORDER
CLEAR
REQUEST
184
CLEAR
COMMAND
186
CLEAR
COMPLETE
188
MOBILE GOES BACK TO DORMANT
STATE AFTER RELEASE ORDER.
BOTH R-P CONNECTION AND PPP
CONNECTION ARE MAINTAINED

Fig. 8

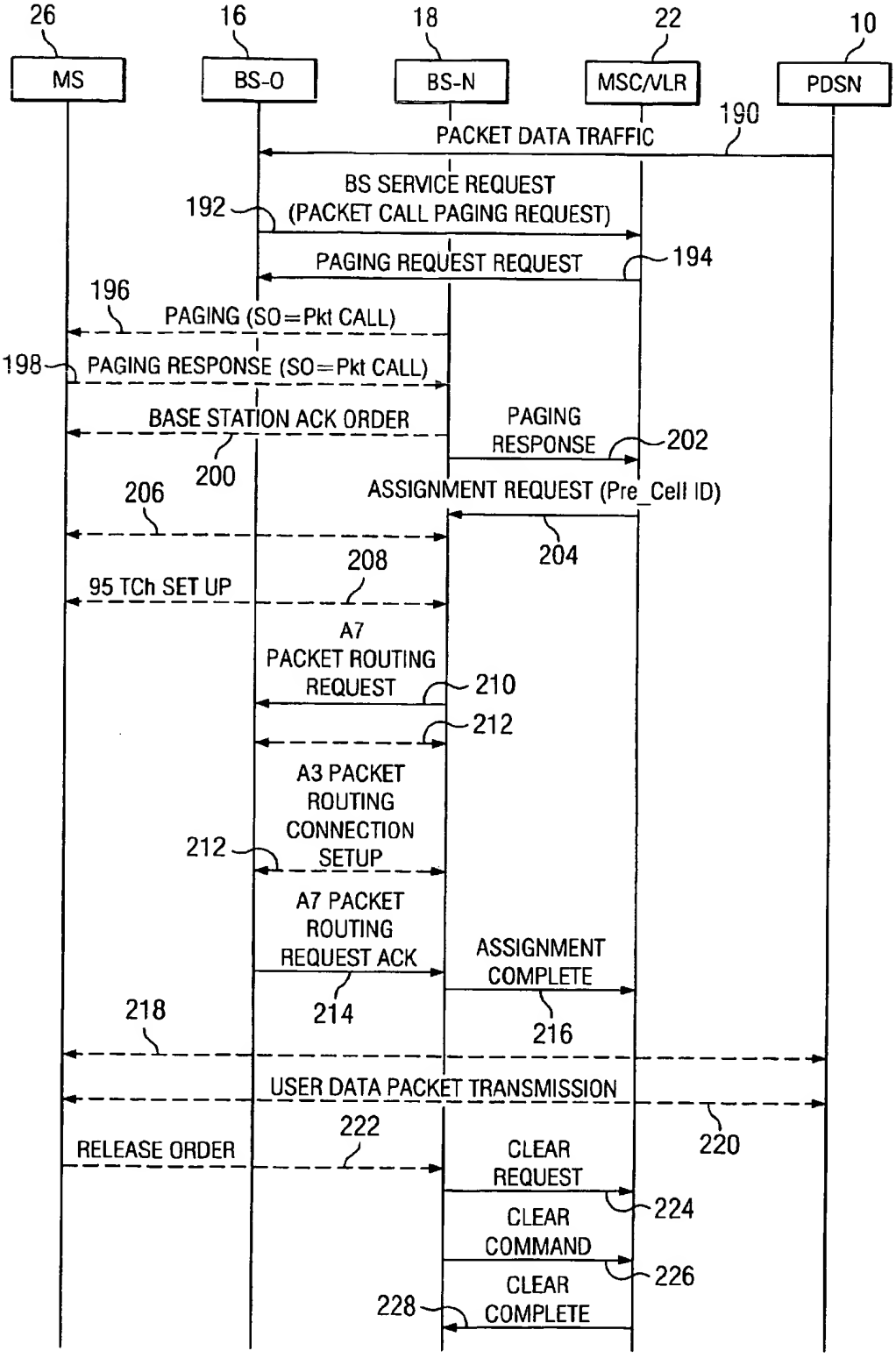

26
16
18
22
10
MS
BS-O
BS-N
MSC/VLR
PDSN
190
PACKET DATA TRAFFIC
BS SERVICE REQUEST
(PACKET CALL PAGING REQUEST)
192
PAGING REQUEST REQUEST
194
196
PAGING (SO=Pkt CALL)
198
PAGING RESPONSE (SO=Pkt CALL)
BASE STATION ACK ORDER
200
PAGING
RESPONSE
202
206
ASSIGNMENT REQUEST (Pre_Cell ID)
204
208
95 TCh SET UP
A7
PACKET ROUTING
REQUEST
210
212
A3 PACKET
ROUTING
CONNECTION
SETUP
212
A7 PACKET
ROUTING
REQUEST ACK
214
ASSIGNMENT
COMPLETE
216
218
USER DATA PACKET TRANSMISSION
220
222
RELEASE ORDER
CLEAR
REQUEST
224
CLEAR
COMMAND
226
228
CLEAR
COMPLETE

Fig. 9

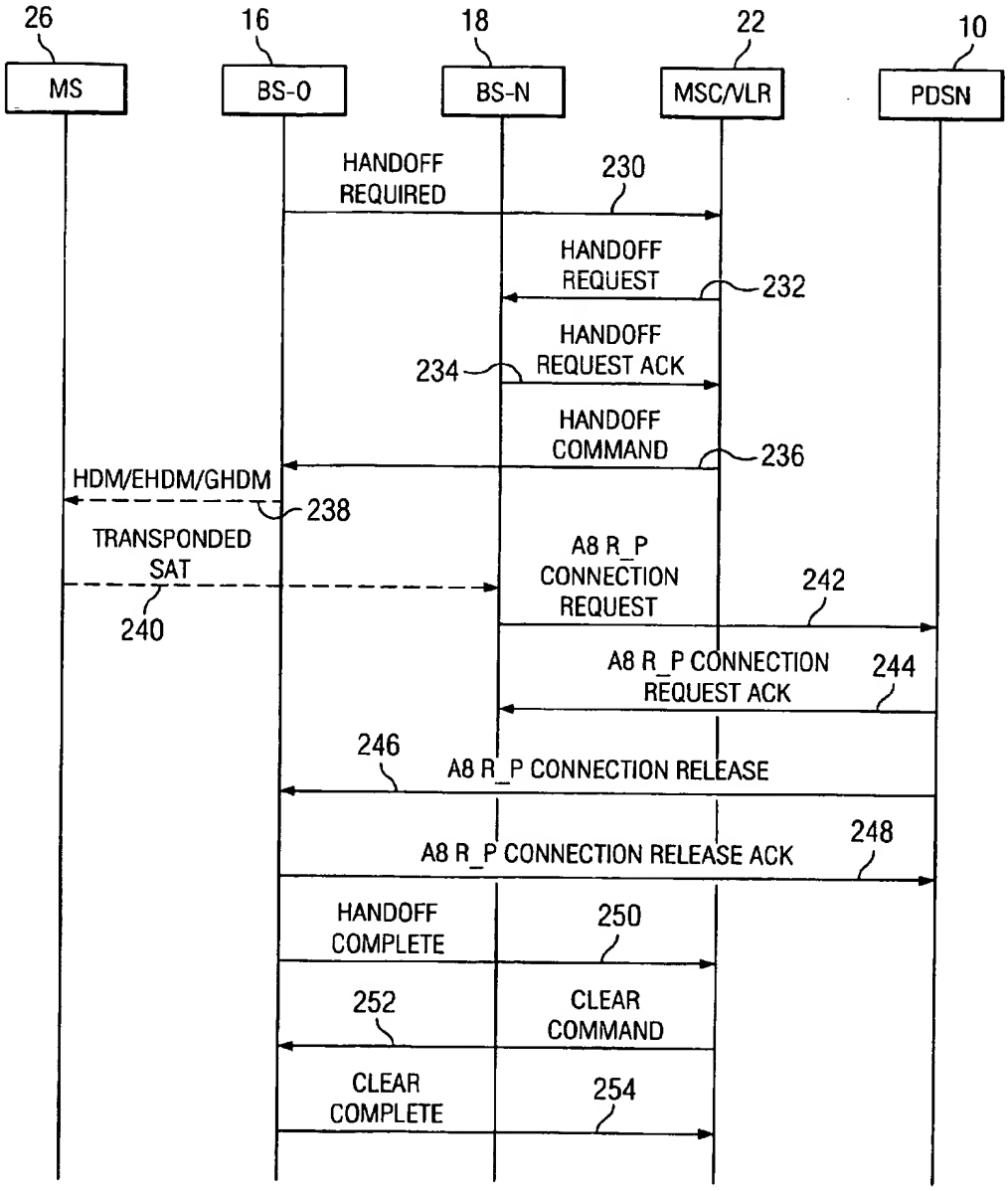

26
16
18
22
10
MS
BS-0
BS-N
MSC/VLR
PDSN
HANDOFF REQUIRED
230
HANDOFF REQUEST
232
HANDOFF REQUEST ACK
234
HANDOFF COMMAND
236
HDM/EHDM/GHDM
238
TRANSPONDED SAT
240
A8 R_P CONNECTION REQUEST
242
A8 R_P CONNECTION REQUEST ACK
244
246
A8 R_P CONNECTION RELEASE
A8 R_P CONNECTION RELEASE ACK
248
HANDOFF COMPLETE
250
252
CLEAR COMMAND
CLEAR COMPLETE
254

Fig. 10

METHOD FOR UPDATING AN R-P CONNECTION FOR A ROAMING MOBILE STATION

CROSS REFERENCE

This application claims the benefit of U.S. Provisional Application Serial No. 60/126,675, which was filed on Mar. 29, 1999.

BACKGROUND OF THE INVENTION

The present invention relates generally to telecommunication systems, and more particularly, to a system and method for updating an R-P connection when a mobile station roams from one radio network to another.

In a telecommunication system, as shown in FIG. **1**, a packet data serving node (PDSN) **10***a* or **10***b* usually serves multiple radio networks (RNs), e.g., **12***a*, **12***b* and **12***c*. On the other hand, a single RN, e.g. **12***b*, can be in communication with more than one PDSN. When a mobile station (MS) roams from one RN to another, a RN-to-PDSN connection (R-P connection) **14** must be updated to maintain a smooth communication channel between the RN **12** and the PDSN **10**.

FIG. **2** shows a communication infrastructure describing the relationship among a PDSN **10**, base station controllers (BSCs) **16**, **18**, and **20**, Visitor's Location Registers (VLRs) or Mobile Service Centers (MSCs) **22**, representative cells of radio networks **24***a* and **24***b*, and a roaming MS **26**. For instance, when the MS **26** roams from one cell **28**, which is under the control of the BSC **16**, to another cell **30** controlled by the BSC **18**, an old R-P connection **32** between the BSC **16** and the PDSN **10** may have to be updated to reflect a new R-P connection **34** between the BSC **18** and the PDSN **10**. Furthermore, the MSC/VLR **22** may be in communication with both the BSC **16** and the BSC **18** without maintaining a communication channel with the PDSN **10**.

In one scenario, when the MS **26** roams to a new radio network, and if a BSC serving the new radio network is under a different PDSN **10**, the MS **26** may have to perform a mobile IP (M-IP) registration process. However, a race condition may happen during the M-IP registration when packets are still routed to the old network before the new M-IP registration has been completed. Hence, it is recommended by the Telecommunication Industry Association (TIA) to relay all these packets from the old radio network to the new radio network.

Although the TIA has dealt with the race condition during the M-IP registration, two other scenarios for switching the R-P connection are not contemplated by the TIA. In one scenario, the new BSC is under the same PDSN **10**, but relates to a different MSC/VLR **22**. As shown in FIG. **2**, this could happen when the MS **26** roams into the territory of the BSC **20** from that of the BSC **16**. In another scenario, the new BSC **20** is under the same PDSN **10** and relates to the same MSC/VLR **22**. This occurs when the MS **26** moves from the control of the BSC **16** to the BSC **18**.

Therefore, an improved method is needed for timely switching or updating an R-P connection when a MS **26** roams into a new radio network.

SUMMARY OF THE INVENTION

A system and method is provided for timely maintaining or establishing an R-P connection after a mobile station (MS) roams from the control of an old base station controller (BSC) to that of a new BSC.

In one embodiment of the present invention, a Mobile Service Center (MSC) or Visitor's Location Register (VLR) stores packet data call status information including point to point protocol (PPP) session status information and configuration information about BSCs. The information may include related cells and pocket data service nodes (PDSNs) before the MS moves to a new radio network (RN). During a registration process of the MS **26**, once a Location Update Request is received from the MS **26**, the MSC/VLR **22** can check whether the MS **26** is in a PPP session and whether the MS **26** is moving to a new BSC but within the same packet zone. If so, the R-P connection can be switched over. In this case, the MSC/VLR **22** will inform the new BSC to establish the R-P connection with the PDSN **10**.

In another embodiment of the present invention, an R-P connection is maintained between the old BSC and the PDSN **10** during a registration process while a routing connection is made between the old BSC and the new BSC.

In another embodiment of the present invention, the MS **26**, instead of the MSC/VLR **22**, stores necessary information such as a PPP session indicator and a cell ID. During the registration process, the new BSC receives information about the R-P connection between the old BSC and the associated PDSN **10** from the MS **26**. Upon determining that a new R-P connection is needed, the PDSN **10** establishes the new R-P connection with the new BSC.

In another embodiment of the present invention, during an origination process, the MS **26** communicates directly with the new BSC. The new BSC subsequently communicates with the MSC/VLR **22** to obtain information about the old R-P connection. The new BSC establishes a new traffic channel with the MS **26** only if needed. The new BSC also checks the PPP session status information and triggers the construction of a new R-P connection.

In yet another embodiment of the present invention, if certain conditions require (e.g., the MS **26** is at an Inter-MSC **22** boundary cell), switching the R-P connection can be avoided. The packet traffic can be routed back to the old BSC via a base station to base station (BS—BS) link. Therefore there is no need to switch the R-P connection.

In another embodiment of the present invention, an R-P connection is initiated during a mobile termination process. Information about the old BSC and its link with the PDSN **10** is transferred to the new BSC.

In another embodiment of the present invention, an R-P connection is maintained during a mobile termination process by routing the packet traffic to the old BSC. A paging process is used for setting up a traffic channel between the new BSC and the MS **26**.

In yet another embodiment of the present invention, information about the old R-P connection and the associated PDSN **10** are given to the new BSC through a hard handoff process. A new R-P connection is then established.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates conventional communication links among Packet Data Serving Nodes (PDSNs) and Radio Networks (RNs).

FIG. **2** illustrates a conventional communication infrastructure describing the relationship among a PDSN, base station controllers (BSCs), Visitor's Location Registers (VLRs) or Mobile Service Centers (MSCs), cells of a radio network, and a roaming MS.

FIG. **3** is a call flow diagram according to one embodiment of the present invention in which the process for

updating an R-P connection is initiated and carried out by an MS registration process through a VLR or MSC.

FIG. **4** is a call flow diagram according to another embodiment of the present invention that updates an R-P connection during a regular mobile registration process by using a communication link between two base station controllers.

FIG. **5** is a call flow diagram according to yet another embodiment of the present invention to establish a new R-P connection with the assistance of the MS.

FIG. **6** is a call flow diagram according to still another embodiment of the present invention for establishing an R-P connection during an origination process when an MS prepares to transmit data after it has roamed from one radio network to another radio network.

FIG. **7** is a call flow diagram illustrating the process for relaying packet data traffic from one base station controller to another during an origination process.

FIG. **8** is a call flow diagram illustrating the construction of an R-P connection during a mobile termination process according to another embodiment of the present invention.

FIG. **9** is a call flow diagram illustrating a process for updating an R-P connection during a mobile termination process by relaying the packet traffic from one base station controller to another.

FIG. **10** is a call flow diagram for an inter-BSC hard handoff within the same PDSN **10** for a roaming MS **26**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

For the sake of illustration, it is assumed that each radio network (RN) has a packet zone identification (PZID), that all communication between the RNs and packet data session nodes (PDSNs) will be via base station controllers (BSCs), and that a PDSN **10** abandons an old R-P connection only after a new R-P connection has been established. The following description uses signaling terminology consistent with IS-2000 or TIA/EIA-95. It is understood, however, that other systems may equally employ the benefits of the present invention.

Referring now to FIG. **3**, a call flow diagram **36** illustrates one embodiment of a process for updating an R-P connection in a wireless communication system. The call flow diagram **36** is initiated and carried out by a mobile station (MS) registration process through a Visitor's Location Registers (VLR) or Mobile Service Centers (MSC). It is understood that operations performed by the VLR **22** can also be performed by the associated MSC **22**.

When the MS **26** moves from the coverage area of an old BSC (BS-O **16**) to the coverage area of a new BSC (BS-N) **18**, it is assumed that the MS **26** has already performed an M-IP registration in a particular packet zone. This is because the BS-N **18** is under the same PDSN **10** as the BS-O **16**. The MS **26** has thus established a Point-to-Point Protocol (PPP) connection with the PDSN **10** via the BS-O **16**.

At step **37**, during a preceding M-IP registration, the BS-O **16** sends information about the R-P connection **32** and the associated PDSN **10** in an Assignment Complete message to the MSC/VLR **22**. In this case, the MSC/VLR **22** stores the call status information including information for PPP session status and configuration information for existing BSCs, cells, and PDSNs. A parameter "PDSN ID" stores the information to identify which PDSN that the BS-O **16** is connected.

At step **38**, when the MS **26** moves into the coverage area of the BS-N **18**, a Registration message is triggered to be sent from the MS **26** to the BS-N **18**. The mechanism to trigger the registration may include time based or zone based registration mechanisms.

At step **39**, upon receiving the Registration message, the BS-N **18** constructs a Location Updating Request message and sends it to the MSC/VLR **22** through a Complete Layer **3** Information message. This message is sent to inform the MSC/VLR **22** that location information of the MS **26** may need to be updated and other appropriate efforts may be taken to assure uninterrupted service to the MS **26**. Having the MS **26** register with the BS-N **18**, the MSC/VLR **22** is able to check whether the MS **26** is in a PPP session and whether the MS **26** is moving to a new BSC but within the same packet zone based on its stored information.

Subsequently at step **40**, the VLR **22** sends a Location Updating Response message to the BS-N **18** to include information about the R-P connection **32** (FIG. **2**) and the associated PDSN **10**. This information may include parameters like R-P Indicator, PDSN ID, Pre_Cel_ID, and session_ID, so that an R-P connection can be established, if needed. The session_ID is an identifier that uniquely indicates a particular instance of packet data service for a MS **26**. The MS **26** may have one or more instances of packet data services simultaneously. The session_ID may also be unique for a predetermined PDSN **10** or an area served by a MSC/VLR **22** as well. Further at step **41**, the BS-N **18** may transmit a Registration Acknowledge message to the MS **26** to indicate a successful registration.

At step **42**, if the BS-N **18** detects the absence of an existing R-P connection between the BS-N **18** and the PDSN **10** for providing packet data services (which is needed for the next round of packet transmission), the BS-N **18** sends an R-P Connection Request message to the PDSN **10**. The message is based on information the BS-N **18** has obtained from the MSC/VLR about the R-P connection between the BS-O **16** and the PDSN **10** (at step **40**).

At step **43**, the PDSN **10** then sets up a new R-P connection with the BS-N **18** and sends an R-P connection Request Ack message back to the BS-N **18**. At step **44**, once the new R-P connection **34** (FIG. **2**) is completed, the PDSN **10** sends an R-P Connection Release message to the BS-O **16** to release the old R-P connection **32**, and at step **45** receives a confirmation from the BS-O **16**. However, in order to maintain network reliability and efficiency, it is not always preferred to establish new R-P connections. Referring again to FIG. **1** for example, if the BS-N **18** is under the RN **12***b* and there is no existing R-P connection with PDSN **10***b*, but there is one with PDSN **10***a*, then a new R-P connection is not preferred. Instead, the existing R-P connection can be used for communications between the RN **12***b* and the PDSN **10***a*. In this case, any new PPP session establishment and the mobile IP registration process will have to be performed by the MS.

Referring to FIG. **4**, a call flow diagram **50** illustrates another embodiment of the present invention that updates an R-P connection during a regular registration by using a communication link between the BS-O **16** and the BS-N **18**. In this embodiment, steps **52**, **54**, **56**, and **57** are similar to steps **38**, **39**, **40**, and **41**, respectively. Thus through steps **52** and **56**, the MSC/VLR **22** can only send information about the previously registered Cell_ID, a session_ID, and a PPP identifier in the Location Updating Accept message to the BS-N.

At step **58**, the BS-N **18** can use information received from the MSC/VLR **22** to locate the BS-O **16** and send an A7 PDSN Info Request message to the BS-O **16** through an

A Interference Link. At step **60**, once the connection is made between the BS-N **18** and the BS-O **16**, the BS-O **16** sends information about the old R-P connection **32** (FIG. **2**) and the associated PDSN **10** in another A7 PDSN Info Request message back to the BS-N **18**. At steps **62–64**, with this information, the BS-N **18** communicates with the PDSN **10** and establishes the new R-P connection **34** with the PDSN **10** through an A8 R-P Connection Request and Ack messages. At steps **66–68**, the PDSN **10** is then directed to communicates with the BS-O **16** to clear the old R-P connection **32**.

Referring to FIG. **5**, a call flow diagram **69** illustrates another embodiment of the present invention for establishing a new R-P connection. The call flow **69** utilizes the MS **26** for providing information about the PDSN **10**. In this embodiment, the MS **26** takes stores information about the PDSN **10** and the related R-P connection **32**.

At step **70**, during an M-IP registration, the PDSN **10** sends information about the PDSN **10** (such as the PDSN_ID) to the MS **26**. At step **72**, during a mobile registration process, the MS **26** uses a Register message to send information about a PPP session status, including current PDSN **10** information, to the BS-N **18**. At steps **74–76**, having the information about the PDSN **10** on hand, the BS-N **18** communicates with the MSC/VLR **22** to update the location of the MS **26**. At steps **78–80**, a new R-P connection **34** is negotiated and established between the PDSN **10** and the BS-N **18**, while the old R-P connection **32** is torn down at steps **82** and **84**. It is understood that in this embodiment, the MS **26** actively participates in the entire process to select an appropriate PDSN based on its stored information about the prior PDSN connection.

As an alternative, at step **72**, the MS **26** can provide information about the BS-O **16** to the BS-N **18**. Using this information, the BS-O **16** and BS-N **18** can establish a routing connection there between so that packet data can be transferred between the MS **26** and the PDSN **10** through the old R-P connection and the routing connection without establishing a new R-P connection.

Referring to FIG. **6**, a call flow diagram **88** illustrates another embodiment of the present invention for establishing an R-P connection during a mobile origination process. The call flow **88** can be performed while a MS **26** prepares to transmit data, even after it has roamed from one RN to another RN. In this embodiment, the MS **26** does not immediately change the PDSN connection when it first roams into the new RN. It will only attempt to do so when it is ready to transmit packet data. Consequently, from the time the MS **26** roams into the coverage area of a new RN to the time it tries to transmit data, the old PDSN connection remains in tact.

In this embodiment, the MSC/VLR **22** stores information about the prior PDSN and the R-P connection. At step **90**, the dormant MS **26** has moved to the coverage area of the BS-N **18**, "wakes up," and transmits an Origination message over an access channel to the BS-N **18** to request a packet data service. At step **92**, the BS-N **18** acknowledges the receipt of the Origination message and at step **94**, sends a CM Service message in a Complete Layer 3 Information format to the MSC/VLR **22**.

At step **96**, the MSC/VLR **22** then sends an Assignment Request message to request assignment of radio resources from the BS-N **18**. In the message, information for the old R-P connection **32** and associated PDSN **10** is included. At steps **98** and **100**, the BS-N **18** communicates with the MS **26** to set up a traffic channel there between. Right after, at steps **102** and **104**, the BS-N **18** and the PDSN **10** complete the establishment of the new R-P connection **34**. At step **106**, the BS-N **18** indicates the completion of the new traffic channel and the R-P connection **34** to the MSC/VLR **22**. At steps **108–110**, the old R-P connection **32** is then released. At step **112**, the MS **26** can start to transmit packet data through packet data services provided by the new R-P connection between the MS **26** and the PDSN **10**.

At step **114**, upon completion of a packet data transmission, if the MS **26** decides to go to the dormant state while still maintaining the PPP connection and the R-P connection, it sends a Release Order message to the BS-N **18**. Since the MS **26** is going dormant, the radio resources can be freed to serve other needs of the system. At step **116**, the BS-N **18** sends a Clear Request message to the MSC/VLR **22** to initiate a radio resource release transaction. At step **118**, the MSC/VLR **22** delivers a Clear Command message to the BS-N **18** to instruct it to release certain dedicated resources previously assigned for the MS's communication. Upon releasing the radio resources, the BS-N **18** signals the MSC/VLR **22** by sending a Clear Complete message at step **119**. In fact, the MS **26** may go dormant as soon as the Release Order message is sent.

Referring to FIG. **7**, a call flow diagram **120** illustrates an embodiment of the present invention for establishing a new R-P connection. The call flow **120** relays the traffic from the BS-N **18** to the BS-O **16** during an origination process. In this case, steps **121**, **122**, **124**, **126**, **128**, and **130** are similar to steps **90**, **92**, **94**, **96**, **98**, and **100**, respectively, in FIG. **6** as described above. Once the radio resources are assigned, a traffic channel is set up between the MS **26** and the BS-N **18**. When the BS-N **18** detects no existing R-P connection, it can find information about the BS-O **16** through parameters such as Cell_ID, which has been sent from the MSC/VLR **22** to the BS-N **18** at step **126**. Therefore, the BS-N **18** can choose not to establish any new R-P connection, but instead route the packet data it receives to the BS-O **16**. In order to make such a connection with the BS-O **16**, the BS-N **18** can do so through an A3 packet routing connection setup process.

At steps **132**, **134**, and **136**, the BS-N **18** and the BS-O **16** establish the packet routing connection through messages such as an A7 Packet Routing Request, an A3 Packet Routing Connection Setup, and an A7 Packet Routing Ack. At steps **138** and **140**, after the MSC/VLR **22** is informed about the completion of the traffic and packet routing connections, data packets are freely transferred between the MS **26** and the PDSN **10**. In this case, the packet traffic is routed from the MS **26** to the BS-N **18**, to the BS-O **16** through the established routing connection, and from the BS-O **16** to the PDSN **10** via the existing and unchanged R-P connection **32**. If at the end of a packet transmission the MS **26** goes to a dormant state, steps **142**, **144**, **146**, and **148** can be taken similar to steps **114**, **116**, **118**, and **119**, respectively, in FIG. **6**.

Referring to FIG. **8**, a call flow diagram **149** illustrates an embodiment of the present invention for construction of a new R-P connection. The call flow **149** can be performed during a mobile termination process according to another embodiment of the present invention. The BS-O **16** may prepare to transmit data to the MS **26** after the MS **26** has roamed into the coverage area of the BS-N **18**. In this embodiment, the R-P connection is not changed when the MS **26** first roams into the coverage area of the BS-N **18** from that of the BS-O **16**. Therefore, from the time that the MS **26** leaves the coverage area of the BS-O **16** to the time when data arrives in the BS-O **16** from the PDSN **10**, the R-P connection has been preserved.

At step **150**, the PDSN **10** sends data packets to the BS-O **16** on the existing R-P connection **32**. At step **152**, the BS-O **16** initiates a Paging process by sending a BS Service Request message to the MSC/VLR **22** for locating the MS. This message may include information for identifying certain MSs (e.g., mobile identification parameters such as MIN or IMSI). Then at step **154**, the MSC/VLR **22** sends a Paging Request message to start a mobile terminated packet data call setup process. This message can be sent to either all BSCs under the coverage of the PDSN **10** if the MSC/VLR **22** does not use a "zone paging technique," or as an alternative, sent to all BSCs in the entire communication system in which the PDSN is located. At step **156**, the BS-N **18** pages all MSs under its coverage in a paging message, and at step **158**, the MS **26** responds to the BS-N **18** (instead of the BS-O **16**) through a paging response message since it is now in the coverage area of BS-N **18**. Further at step **160**, the BS-N **18** acknowledges the communication with the MS **26** by sending a Base Station Ack Order message to the MS **26**.

Immediately thereafter at step **162**, the BS-N **18**, in lieu of the BS-O **16**, responds to the MSC/VLR's paging process by constructing and sending a Paging Response message in a Complete Layer 3 Information format. Then at step **164**, the MSC/VLR **22** sends an Assignment Request message to the BS-N **18** to provide information about packet data call status information such as the PDSN_ID for the BS-N **18** to establish a new R-P connection. After a traffic channel is established at steps **166** and **168**, the new R-P connection **34** is then constructed at steps **170** and **172** and the communication resources assignment is completed at step **174**. Steps **176**, **178**, **180**, **182**, **184**, **186**, and **188** are similar to corresponding steps described in FIG. **6** which carry out the functions of releasing the old R-P connection **32**, and releasing the radio sources while the MS **26** goes dormant.

Referring to FIG. **9**, a call flow diagram **189** illustrates an embodiment of a process for updating an R-P connection during a subsequent termination process by relaying the packet traffic through the BS-O **16**. In the present embodiment, steps **190**, **192**, **194**, **196**, **198**, **200**, **202**, **204**, **206**, and **208** are similar to steps **150**, **152**, **154**, **156**, **158**, **162**, **164**, **166**, and **168**, respectively, in FIG. **8**, by using a paging method to establish a traffic channel between the BS-N **18** and the MS **26**. Thereafter, similar to what has been described regarding steps **132**, **134**, and **136** of FIG. **7**, messages such as an A7 Packet Routing Request, an A3 Packet Routing Connection Setup, and an A7 Packet Routing Request Ack are used to construct a routing connection between the BS-O **16** and the BS-N **18**. Hence, the packet traffic can be routed from the BS-N **18** to the BS-O **16**, and then from the BS-O **16** to the PDSN **10** via the existing R-P connections **32**. Steps **216**, **218**, **220**, **222**, **224**, **226**, and **228** are similar to process steps described in FIG. **7** and **8**, which help the MS **26** and the PDSN **10** to communicate and releases the assigned radio resources once the MS **26** goes back to dormant. In any case, the R-P connection **32** and the PPP connection are maintained.

Referring now to FIG. **10**, a call flow diagram **229** illustrates an embodiment of an inter-BSC hard handoff within the same PDSN **10** for a roaming MS **26**. It is assumed that the handoff is from an IS-2000 or TIA/EIA-95 system to another similar system. It is also assumed that an IS-2000 or TIA/EIA-95 call is not in the inter-BSC soft (or softer) handoff prior to the hard handoff. Consequently, there is no need to remove any A3 connections.

The call flow **229** begins when the MS **26** roams from one RN to another, and in so doing has crossed certain predetermined threshold values that trigger a hard handoff. At step **230**, the BS-O **16** sends a Handoff Required message with a list of related cells to the MSC/VLR **22**. The message may also include information about the existing R-P connection **32** and the associated PDSN. Steps **232** and **234** complete a communication session between the BS-N **18** and the MSC/VLR **22** to prepare for the hard handoff. Among other things, the BS-N **18** attempts to allocate appropriate radio resources for the upcoming handoff.

At step **236**, when the MSC/VLR **22** sends a Handoff Command message to the BS-O **16**, the BS-O **16** is now ready for the handoff. At step **238**, the BSO **16** may send an Extended Handoff Direction Message or General Handoff Direction Message to the MS **26**, but it may not require an acknowledgment message to be sent back from the MS **26**. At step **240**, a Transponded SAT message may be sent from the MS **26** to the BS-N **18**.

Once the hard handoff from the BS-O **16** to the BS-N **18** is complete, steps **242** and **244** set up a new R-P connection **34** via messages between the BS-N **18** and the PDSN **10**. After the new R-P connection **34** is established, the old R-P connection **32** is abolished at steps **246** and **248**. At step **250**, the BS-O **16** sends a Handoff Complete message to the MSC/VLR **22**. At step **252** the MSC/VLR **22** sends a Clear Command to the BS-O **16** for releasing unneeded radio resources. At step **252**, and the BS-O **16** sends a Clear Complete message to the MSC/VLR **22** to notify the MSC/VLR **22** that the resource releasing process has been accomplished.

It is understood that in many of the above described embodiments, if the MS can be connected back to a prior PDSN that it has established a connection with when the MS was in a first radio network, the prior PDSN is used for communicating to the MS while the MS is in the second radio network. This can be accomplished by maintaining a prior R-P connection with the prior PDSN or establishing a new R-P connection with the prior PDSN. If the prior PDSN is no longer reachable by the BSC in the second radio network, the new R-P connection may be established between the new PDSN and the second BSC for providing packet data services there between.

The above disclosure provides many different embodiments, or examples, for implementing different features of the invention. Specific examples of components, and processes are described to help clarify the invention. These are, of course, merely examples and are not intended to limit the invention from that described in the claims.

While the invention has been particularly shown and described with reference to the preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention, as set forth in the following claims.

What is claimed is:

1. A method for updating a radio network to packet data serving node (PDSN) a first R-P connection while a mobile station (NMS) moves from a first radio network to a second radio network, the first radio network being serviced by a first base station controller (BSC) and the second radio network being serviced by a second BSC, the method comprising the steps of:

storing packet data session information including information about the first R-P connection and an associated PDSN when the MS is in the first radio network; and

transferring the stored information to the second BSC when the MS moves into the second radio network,

thereby allowing the second radio network to update the first R-P connection.

2. The method of claim 1 further comprising:

if the MS can be connected back to the PDSN, using the PDSN for communicating to the MS while it is in the second radio network either by maintaining the first R-P connection with the PDSN or establishing a second R-P connection with the PDSN; and

if the PDSN is not reachable by the second BSC, establishing a third R-P connection between a new PDSN and the second BSC for providing packet data services there between.

3. The method of claim 2 wherein the packet data session information is stored in a Mobile Service Center (MSC).

4. The method of claim 2 wherein the packet data session information is stored in a Visitor's Location Register (VLR).

5. The method of claim 2 wherein the packet data session information is stored in the MS.

6. The method of claim 1 wherein the step of transferring is done in a hard handoff process.

7. The method of claim 1 wherein the packet data session information is stored in a Mobile Service Center (MSC).

8. The method of claim 1 wherein the packet data session information is stored in a Visitor's Location Register (VLR).

9. The method of claim 1 wherein the packet data session information is stored in the MS.

10. A method for updating a radio network to a packet data serving node (PDSN) a first R-P connection while a mobile station (MS) moves from a first radio network to a second radio network, the first radio network being serviced by a first base station controller (BSC) and the second radio network being serviced by a second BSC, the first BSC having the first R-P connection with the PDSN, the method comprising the steps of:

storing packet data session information including information about the first R-P connection and the PDSN in a Mobile Service Center (MSC) when the MS is in the first radio network; and

transferring the stored information to the second BSC after the MS moves into the second radio network thereby allowing the second radio network to update the first R-P connection.

11. The method of claim 10 further comprising the steps of:

if the MS can be connected back to the PDSN through either the first R-P connection or a second R-P connection between the second BSC and the PDSN, communicating to the MS through the PDSN while the MS is in the second radio network; and

if the PDSN is not reachable by the second BSC, establishing a third R-P connection between the second BSC and a new PDSN for providing packet data services between.

12. The method of claim 10 wherein the packet data session information is stored in a Visitor's Location Register (VLR) associated with the MSC.

13. The method of claim 10 wherein the step of transferring includes the step of transferring the stored information to the second BSC during a mobile origination process when the MS has packet data to be sent.

14. The method of claim 10 wherein the step of storing further includes a step of sending the information from the first BSC to the MSC in a communication message.

15. The method of claim 10 wherein the step of transferring further includes the steps of:

registering the MS with the second BSC when it moves into the second radio network;

triggering a message to be sent from the second BSC to the MSC to update the location of the MS; and

sending the stored information about the first R-P connection and the PDSN from the MSC to the second BSC,

whereby the stored information directs the second BSC to communicate with the PDSN for updating the first R-P connection with the PDSN.

16. The method of claim 10 wherein the step of updating the first R-P connection with the first PDSN further includes the steps of:

establishing a second R-P connection between the second BSC and the PDSN; and

abandoning the first R-P connection between the first BSC and the PDSN.

17. The method of claim 10 wherein the step of transferring further includes the steps of:

triggering the second BSC to communicate with the MSC to obtain the stored information about the first BSC;

establishing a routing connection between the second BSC and the first BSC; and

routing packet data transferred between the MS and the PDSN through the first R-P connection and the established routing connection between the first and the second BSCs.

18. The method of claim 17 wherein the second BSC communicates with the MSC during a mobile origination process of the MS.

19. The method of claim 17 further includes a step of establishing a traffic channel between the second BSC and the MS.

20. A method for updating a prior radio network to packet data serving node (PDSN) a first R-P connection while a mobile station (MS) moves from a first radio network to a second radio network, the first radio network being serviced by a first base station controller (BSC) and the second radio network being serviced by a second BSC, the first BSC having the first R-P connection with the PDSN, the method comprising the steps of

storing packet data session information including information about the first R-P connection and the PDSN in a Mobile Service Center (MSC) when the MS is in the first radio network; and

transferring the stored information to the second BSC after the MS moves into the second radio network thereby allowing the second radio network to update the first R-P connection wherein the transferring includes paging the first BSC by the PDSN for locating the MS; requesting the MSC to page a predetermined set of BSCs affiliated with the MSC; locating the MS by the second BSC through a paging process; transferring the stored information from the MSC to the second BSC; and establishing a second R-P connection between the second BSC and the PDSN.

21. The method of claim 20 further includes a step of abandoning the first R-P connection between the first BSC and the first PDSN.

22. The method of claim 20 wherein the step of paging is conducted when packet data need to be sent from the PDSN to the MS.

23. The method of claim 20 wherein the step of paging is conducted during a mobile termination process.

24. A method for updating a radio network to packet data serving node (PDSN) a first R-P connection while a mobile station (MS) moves from a first radio network to a second radio network, the first radio network being serviced by a

first base station controller (BSC) and the second radio network being serviced by a second BSC, the first BSC having the first R-P connection with the PDSN, the method comprising the steps of:

storing packet data session information including information about the first R-P connection and the PDSN in a Mobile Service Center (MSC) when the MS is in the first radio network; and

transferring the stored information to the second BSC after the MS moves into the second radio network thereby allowing the second radio network to update the first R-P connection wherein the transferring includes paging the first BSC by the PDSN for locating the MS; requesting the MSC to page a predetermined set of BSCs affiliated with the MSC; locating the MS by the second BSC through a paging process; transferring the stored information from the MSC to the second BSC; establishing a routing connection between the second BSC and the first BSC based on the transferred information; and routing packet data transferred between the MS and the PDSN through the first R-P connection and the established routing connection between the first and the second BSCs.

25. The method of claim **24** wherein the step of paging is conducted during a mobile termination process.

26. A method for updating a first radio network to a packet data serving node (PDSN) a first R-P connection while a dormant mobile station (MS) moves from the first radio network to a second radio network, the first radio network being serviced by a first base station controller (BSC) and the second radio network being serviced by a second BSC, the first radio network having the first R-P connection between the first BSC and a packet data serving node (PDSN), the method comprising the steps of:

storing packet data session information including information about the first R-P connection and the PDSN in the MS when the MS is in the first radio network; and

transferring the stored information to the second BSC during a registration process of the MS when the MS moves into the second radio network thereby allowing the second radio network to update the first R-P connection.

27. The method of claim **26** wherein if the MS can be connected back to the PDSN through either the first R-P connection or establishing a second R-P connection between the second BSC and the PDSN, the PDSN is used for communicating to the MS while the MS is in the second radio network, and if the PDSN is not reachable by the second BSC, the third R-P connection is established between the second BSC and a new PDSN for providing packet data services between.

28. The method of claim **26** wherein the step of storing is conducted during a Mobile IP registration process.

29. The method of claim **26** wherein the step of transferring further includes the steps of:

transferring the stored information to the second BSC from the MS during a mobile origination process; and

establishing a second R-P connection between the second BSC and the PDSN based on the transferred information from the MS.

30. The method of claim **29** further includes the step of abandoning the first R-P connection between the first BSC and the PDSN before establishing the second R-P connection.

31. The method of claim **26** wherein the step of transferring further includes the steps of:

transferring the stored information to the second BSC from the MS after the MS moves into the second radio network;

establishing a routing connection between the second BSC and the first BSC based on the stored information,

wherein packet data is transferred between the MS and the PDSN through the first R-P connection and the established routing connection between the first and the second BSCs.

32. A method for updating a radio network to packet data serving node (PDSN) a first R-P connection while a dormant mobile station (MS) moves from a first radio network to a second radio network, the first radio network having the first R-P connection with the PDSN, the first radio network being serviced by a first base station controller (BSC) and the second radio network being serviced by a second BSC, the method comprising the steps of:

storing packet data session information including information about the first R-P connection and the PDSN in a Mobile Service Center (MSC) when the MS is in the first radio network;

triggering a hard handoff between the first BSC and the second BSC whereby the stored information is released from the MSC to the second BSC; and

updating the first R-P connection between the second BSC and the PDSN,

wherein the first R-P connection allows packet data to be sent from the MS to the PDSN there through.

33. The method of claim **32** wherein the packet data session information is stored in a Visitor's Location Register (VLR) associated with the MSC.

34. The method of claim **32** wherein the step of updating further includes the steps of:

establishing a second R-P connection between the second BSC and the PDSN; and

abandoning the first R-P connection between the first BSC and the PDSN.

35. A method for updating a first radio network to packet data serving node (PDSN) a first R-P connection while a mobile station (MS) moves from the first radio network to a second radio network, the first radio network being serviced by a first base station controller (BSC) and the second radio network being serviced by a second BSC, the first BSC having the first R-P connection with the PDSN, the method comprising the steps of:

storing information about the first BSC in a Mobile Service Center (MSC) when the MS is in the first radio network;

informing the second BSC the stored information for identifying the first BSC after the MS moves into the second radio network; and

transferring information about the first R-P connection and the PDSN from the first BSC to the second BSC in order to establishing a second R-P connection between the second BSC and the PDSN.

36. The method of claim **35** further includes the step of abandoning the first R-P connection after establishing the second R-P connection between the second BSC and the PDSN.

37. The method of claim **35** wherein the information stored by the MSC about the first BSC includes a cell identifier, session identifier, and a point-to-point identifier.

38. The method of claim **35** wherein the step of transferring is conducted through an A interference link.

39. The method of claim **35** wherein the information about the first BSC is stored in a Visitor's Location Register (VLR) associated with the MSC.

40. A system for updating a first radio network to packet data serving node (PDSN) a first R-P connection while a mobile station (MS) moves from the first radio network to a second radio network, the first radio network being serviced by a first base station controller (BSC) and the second radio network being serviced by a second BSC, the system comprising:

means for storing packet data session information including information about the first R-P connection and an associated packet data serving node (PDSN) when the MS is in the first radio network; and

means for transferring the stored information to the second BSC when the MS moves into the second radio network thereby allowing the second radio network to update the first R-P connection.

41. The system of claim 40 wherein if the MS can be connected back to the PDSN, the PDSN is used for communicating to the MS while it is in the second radio network either by maintaining the first R-P connection with the PDSN or establishing a second R-P connection with the PDSN, and if the PDSN is not reachable by the second BSC, a third R-P connection is established between a new PDSN and the second BSC for providing packet data services there between.

42. The system of claim 41 wherein the packet data session information is stored in a Mobile Service Center (MSC).

43. The system of claim 41 wherein the packet data session information is stored in a Visitor's Location Register (VLR).

44. The system of claim 41 wherein the packet data session information is stored in the MS.

45. The system of claim 40 wherein the means for transferring is done in a hard handoff process.

46. The system of claim 40 wherein the packet data session information is stored in a Mobile Service Center (MSC).

47. The system of claim 40 wherein the packet data session information is stored in a Visitor's Location Register (VLR).

48. The system of claim 40 wherein the packet data session information is stored in the MS.

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